# Results of Frame Error Rate Versus Speed for 11/23/1991

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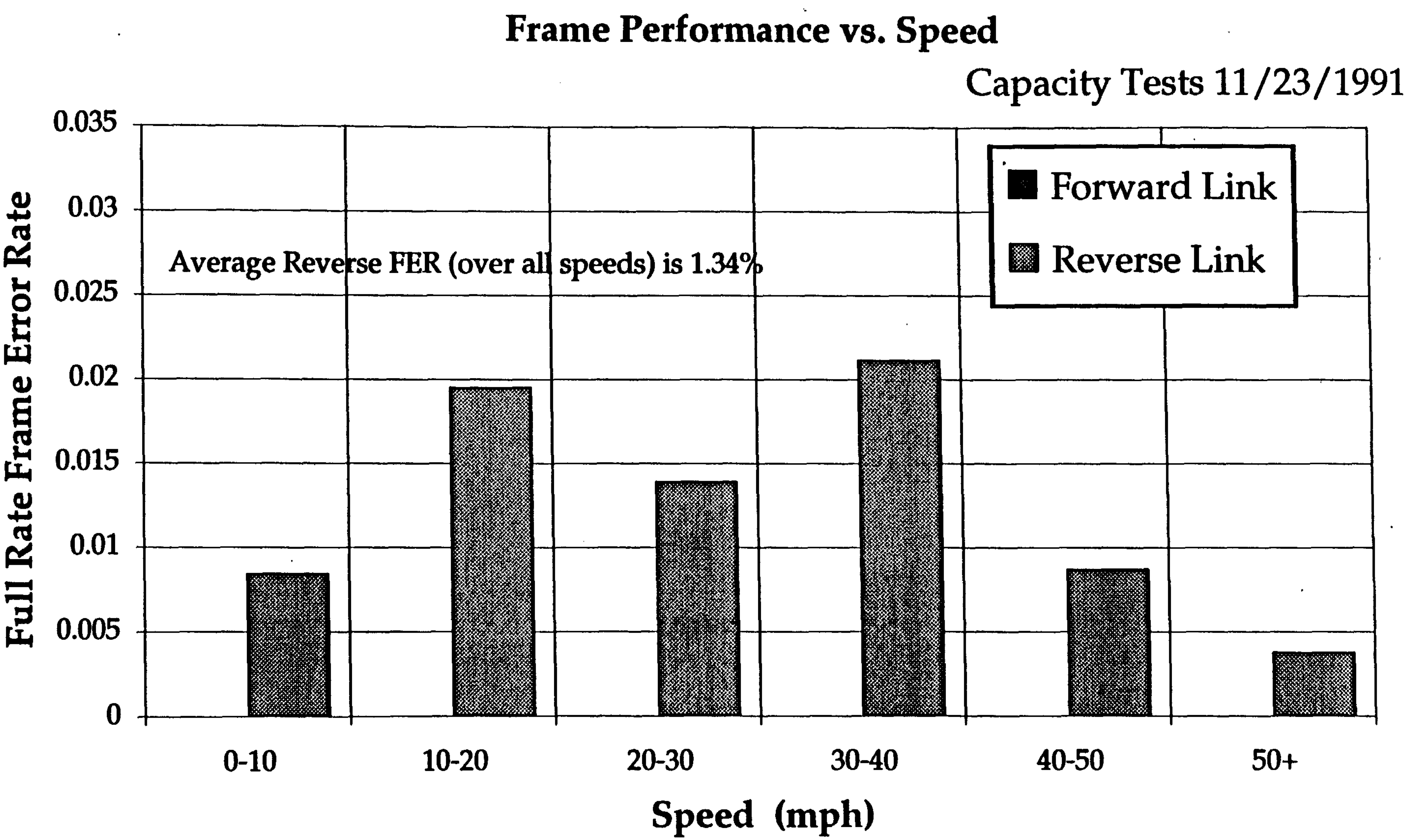
Frame Performance vs. Speed
Capacity Tests 11/23/1991
Forward Link
Reverse Link
Average Reverse FER (over all speeds) is 1.34%
Full Rate Frame Error Rate
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0-10
10-20
20-30
30-40
40-50
50+
Speed (mph)

| Table 7.2.3-5: Summary of FER versus Speed for November 23, 1991 | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| | Forward Link FER vs Speed | | | Reverse Link FER vs Speed | | |
| 5mph Speed Bin | Count of Frame Errors | Count of Total Frames | Forward FER/Speed | Count of Frame Errors | Count of Total Frames | Reverse FER/Speed |
| 0-5 | | | | 386 | 65063 | 0.59% |
| 5-10 | | | | 415 | 29468 | 1.41% |
| 10-15 | | | | 985 | 46672 | 2.11% |
| 15-20 | | | | 758 | 42629 | 1.78% |
| 20-25 | | | | 625 | 43654 | 1.43% |
| 25-30 | | | | 490 | 36313 | 1.35% |
| 30-35 | | | | 605 | 24884 | 2.43% |
| 35-40 | | | | 535 | 29019 | 1.84% |
| 40-45 | | | | 229 | 21405 | 1.07% |
| 45-50 | | | | 83 | 14386 | 0.58% |
| 50-55 | | | | 69 | 16119 | 0.43% |
| 55+ | | | | 77 | 22397 | 0.34% |
| | | | | | | |
| 10mph Speed Bin | | | Forward FER/Speed | | | Reverse FER/Speed |
| 0-10 | | | | | | 0.85% |
| 10-20 | | | | | | 1.95% |
| 20-30 | | | | | | 1.39% |
| 30-40 | | | | | | 2.11% |
| 40-50 | | | | | | 0.87% |
| 50+ | | | | | | 0.38% |
| Longterm FER/Speed | | | | | | 1.34% |

# 7.3 Cell Rx $E_b/N_0$ Results

Cell Rx $E_b/N_0$, or the ratio between the energy of each information bit ($E_b$) and the noise spectral density ($N_0$) required to provide acceptable Frame Error Rate (FER) performance in the received Traffic Channel (Rx) at the cell, was calculated for each run for full rate (9600 bps) received and all rates received. Table 7.3-1. details the average $E_b/N_0$ for each day with the mean and standard deviation for all received traffic channel rates as well as the full rate.

**Table 7.3-1. Average Received $E_b/N_0$ - Setpoint $E_b/N_0$ [dB]**

| Date | Number of Mobiles (run #) | FER Set [%] | Average $E_b/N_0$ | Mean and Std Deviation, for only Rx Full Rate | Mean and Std Deviation, for All Rx Rates |
|---|---|---|---|---|---|
| 11/18/1991 | 30 (1-4)<br>40 (5-6)<br>50 (7-8)<br>61 (9) | 1 %<br>1 %<br>1 %<br>1 % | 6.0 dB | Mean = 0.1 [dB]<br>Std. Dev. = 1.0 [dB] | Mean = 0.2 [dB]<br>Std. Dev. = 1.2 [dB] |
| 11/20/1991 | 30 (1-4)<br>33 (5-6)<br>25 (7-8) | 1 %<br>1 %<br>1 % | 8.6 dB | Mean = 0.6 [dB]<br>Std. Dev. = 2.2 [dB] | Mean = 0.7 [dB]<br>Std. Dev. = 1.1 [dB] |
| 11/21/1991 | 20 (1-3)<br>30 (4-7)<br>40 (8-9)<br>47 (10) | 1 %<br>1 %<br>1 %<br>1 % | 8.2 dB | Mean = 0.5 [dB]<br>Std. Dev. = 1.1 [dB] | Mean = 0.6 [dB]<br>Std. Dev.= 2.1 [dB] |
| 11/22/1991 | 60 (1-2,4)<br>58 (3)<br>62 (5)<br>63 (6)<br>63 (7)<br>65 (8-9) | 1 %<br>1 %<br>1 %<br>1 %<br>1 %<br>0.5 % | 7.9 dB | Mean = 0.4 [dB]<br>Std. Dev. = 1.1 [dB] | Mean = 0.5 [dB]<br>Std. Dev. = 1.8 [dB] |
| 11/23/1991 | 40 (2-4)<br>60 (5-7) | 0.5 %<br>0.5 % | 8.1 dB | Mean = 0.6 [dB]<br>Std. Dev. = 1.1 [dB] | Mean = 0.5 [dB]<br>Std. Dev. = 2.2 [dB] |

Because most of the traffic channels logged for these tests were in soft handoff, the average $E_b/N_0$ was on the high side. The power control threshold of cell Rx $E_b/N_0$ is varied by an outer loop and is based on the setting of Frame Error Rate (FER). Most of the capacity tests were conducted with parameters set for a 1% FER except for two tests where the parameters were set for a 0.5% FER during runs 8 and 9 on November 22 and all runs for November 23.

## Other Factors

The November 20 tests (Mission Bay alpha sector only) showed unexpected variability in the reverse link power control loop with 35 mobiles. This resulted from two problems: The cell demodulation timing algorithm caused the traffic channel to lose the signal from the mobile temporarily under certain multipath conditions. When a strong multipath occured during a deep fade of the direct path, the cell timing jumped to the multipath. If the multipath then faded, the cell search window was often too narrow to reacquire the direct path quickly. The cell would instruct the mobile to raise its power, often to the maximum available power, resulting in reverse link interference. In addition, the adjustment of the reverse link $E_b/N_0$ set point under the previously mentioned interference conditions was not accurate. The interference caused the set points of most mobiles to be raised to as much as 9 dB, a setting at which the capacity of the system is limited to about 35 mobiles in order to maintain stability in the reverse power control loop. These issues have been resolved by modifications to the cell's traffic channel software.

# Cell $E_b/N_0$ Charts for 11/18/1991 through 11/23/1991

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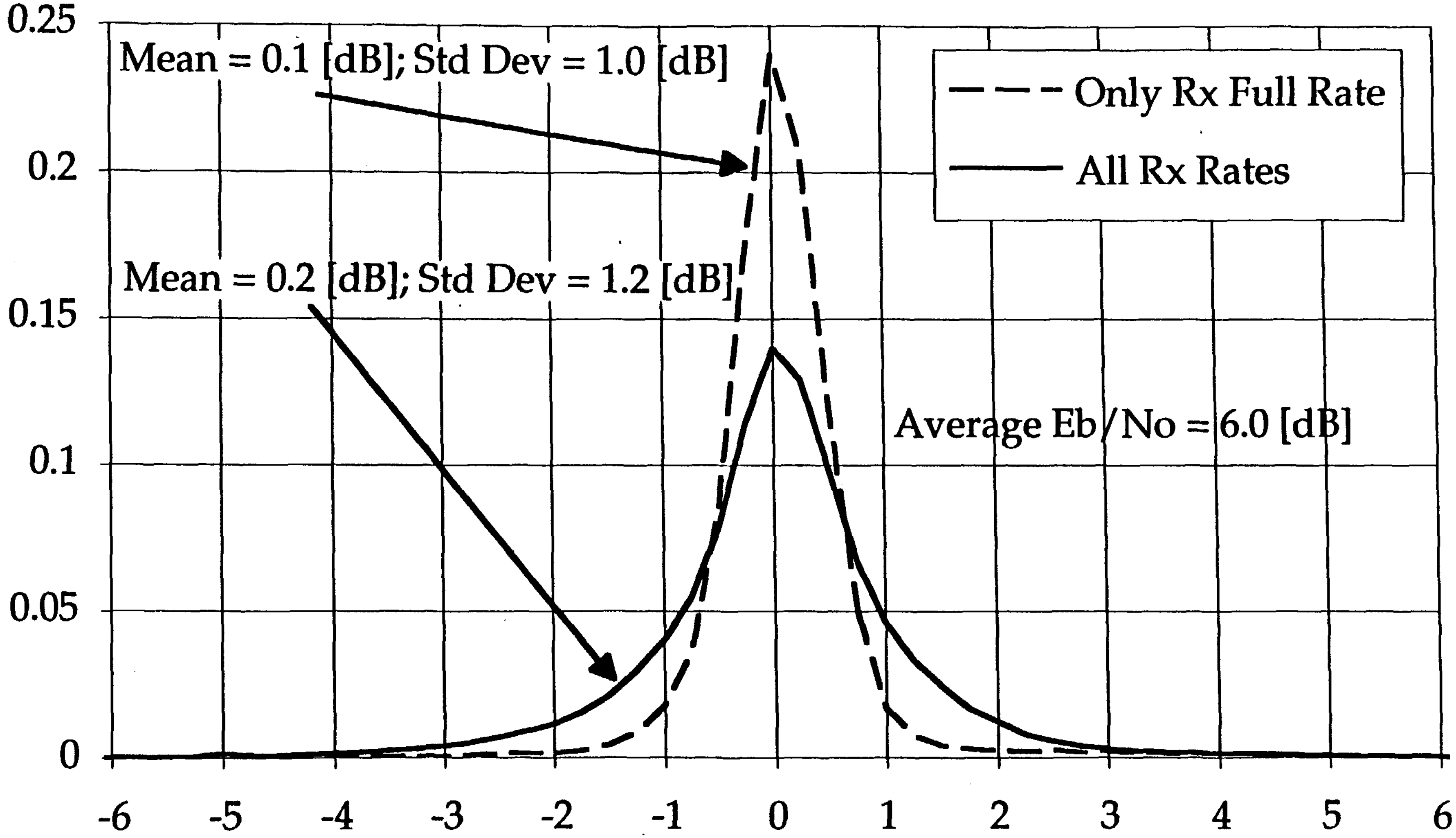
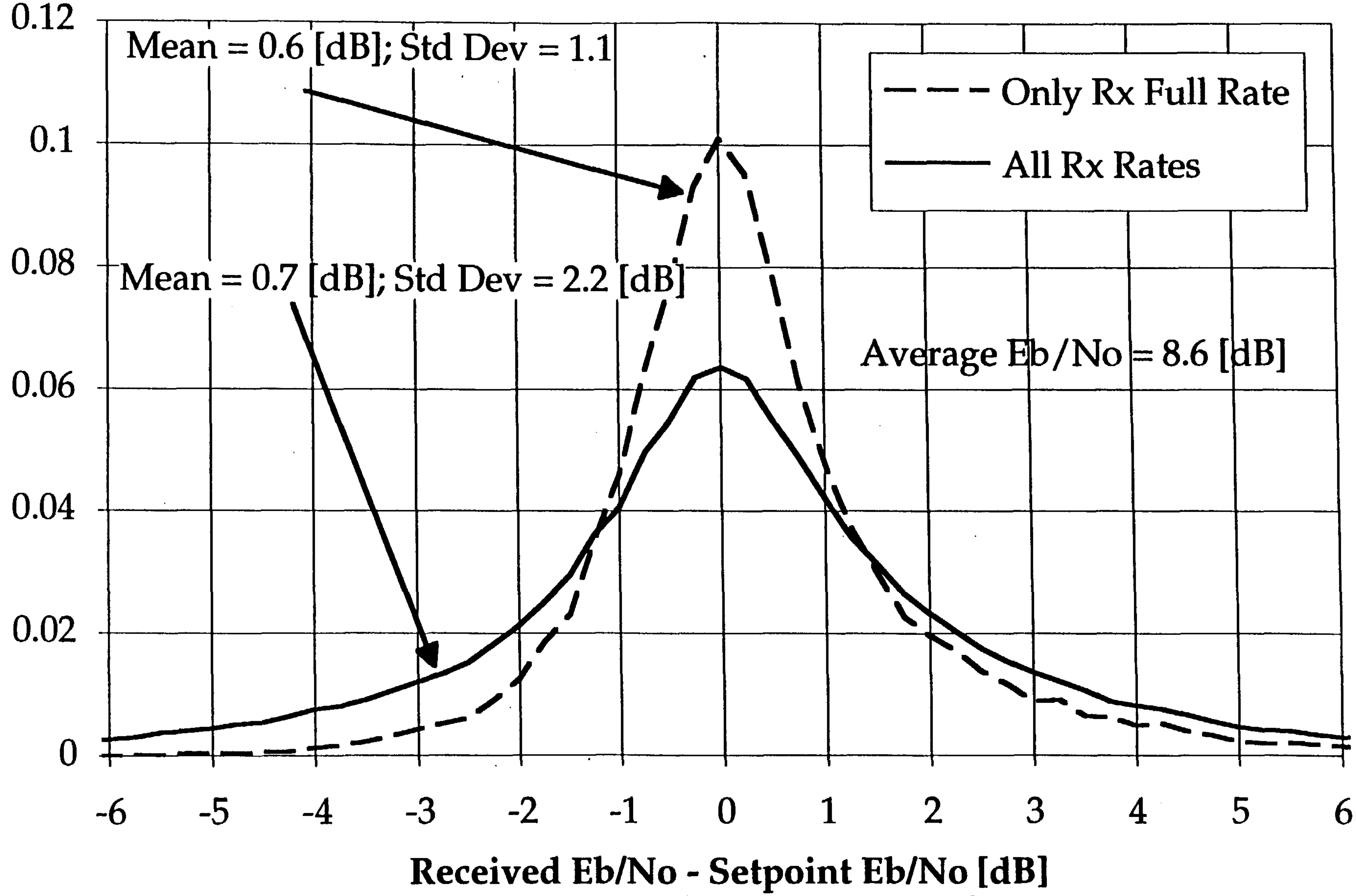
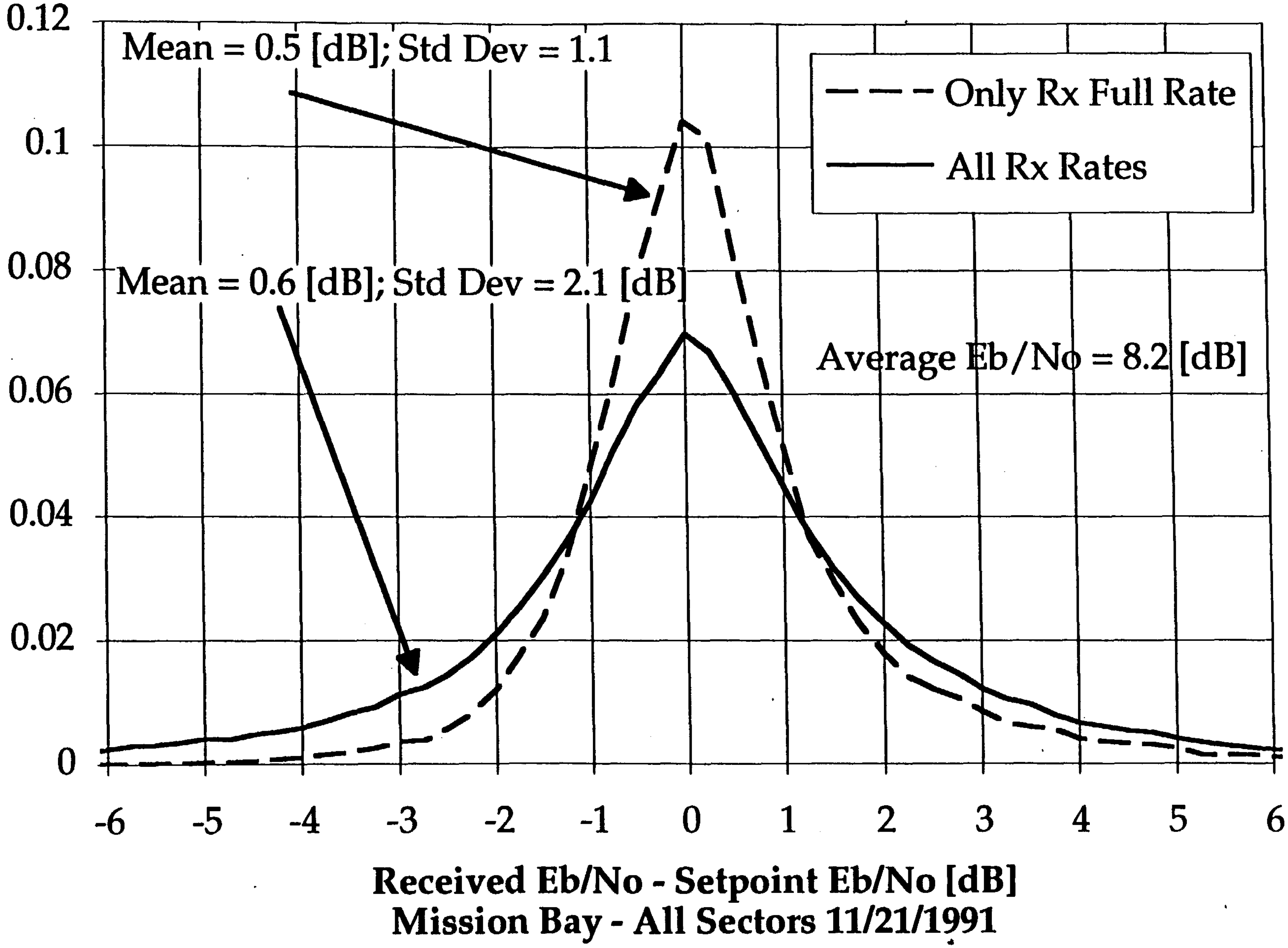
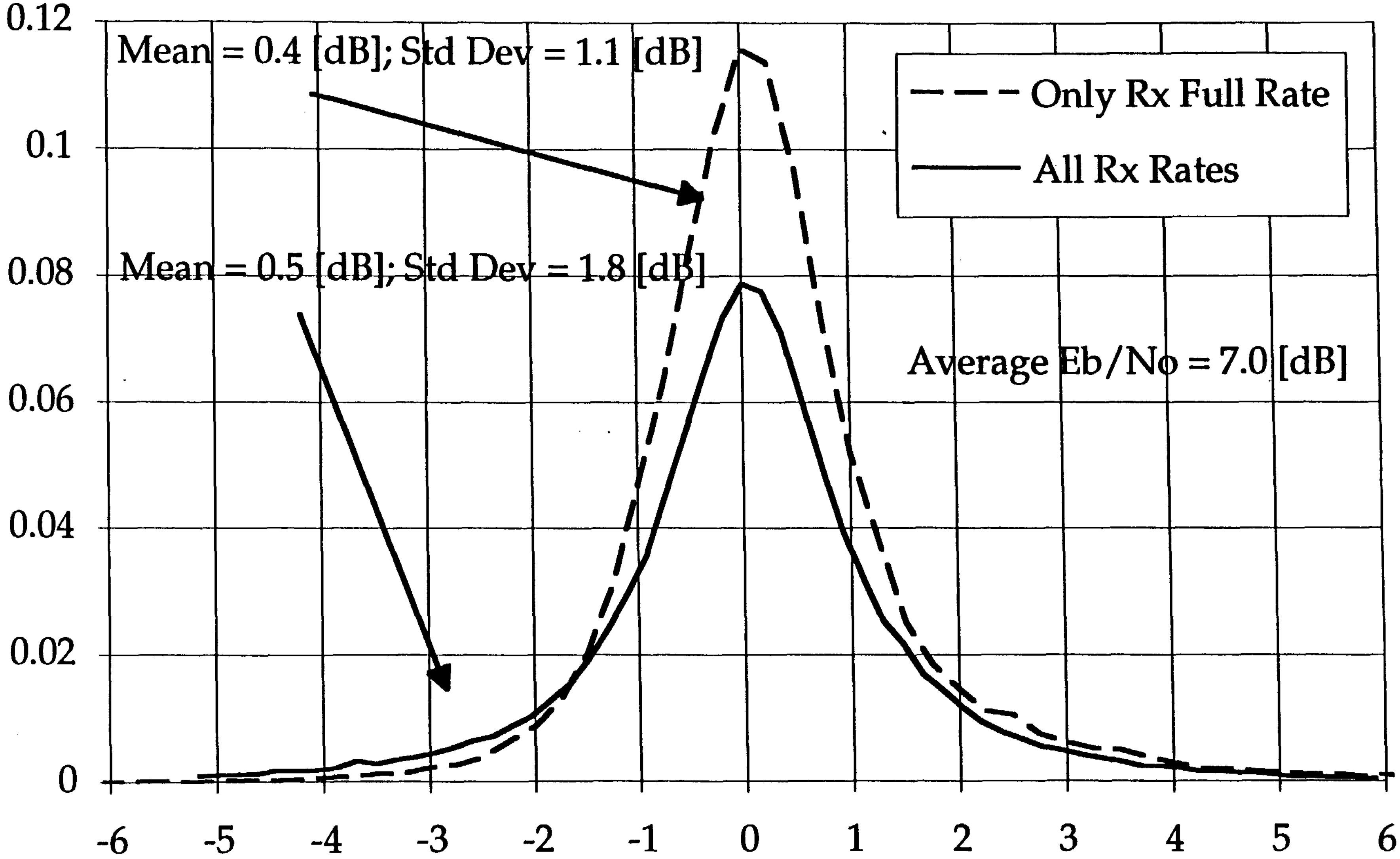



**Received Eb/No - Setpoint Eb/No [dB]**
**Mission Bay - Gamma Sector 11/18/1991**

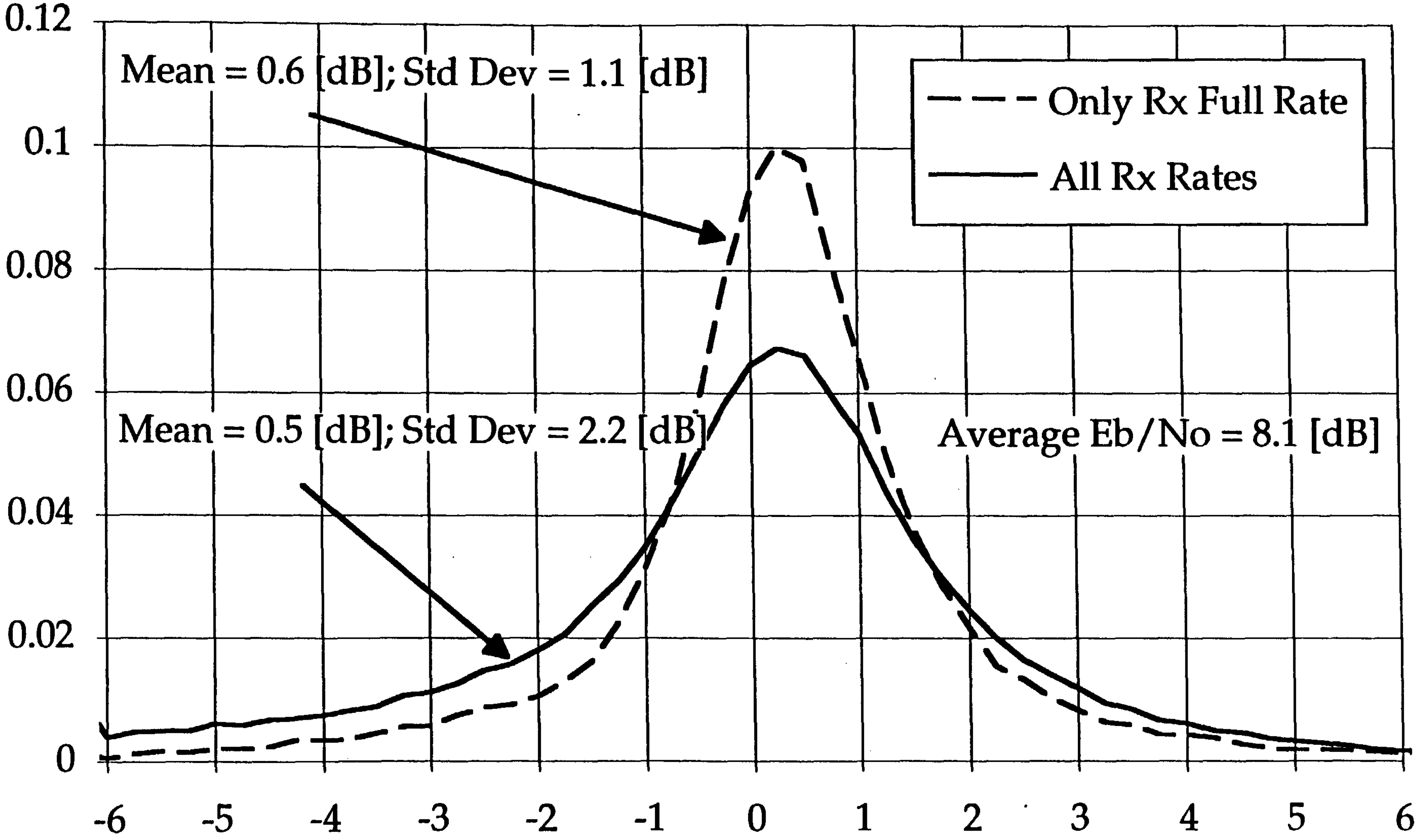



**Mission Bay - Alpha Sector 11/20/1991**


0.12
0.1
0.08
0.06
0.04
0.02
0
Mean = 0.5 [dB]; Std Dev = 1.1
Mean = 0.6 [dB]; Std Dev = 2.1 [dB]
Only Rx Full Rate
All Rx Rates
Average Eb/No = 8.2 [dB]
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
Received Eb/No - Setpoint Eb/No [dB]
Mission Bay - All Sectors 11/21/1991




**Received Eb/No - Setpoint Eb/No [dB]**
**Mission Bay - All Sectors 11/22/1991**




**Received Eb/No - Setpoint Eb/No [dB]**
**All Cells 11/23/1991**

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## 7.4 Tx Power Results

The Tx power of the mobile or the instantaneous transmitting power, was calculated based on the mobile received power (Rx power) and the mobile transmit gain adjust (Tx gain adj) logged signals. During the capacity tests, the instantaneous received AGC levels at the mobile were logged. Based on the logged AGC and a pre-measured calibration table for each mobile, the Rx power of the mobile was calculated. Once the Rx power was available, the Tx power was calculated based on the calculated Rx power and the mobile Tx gain Adj. calibration table .

The distribution of Tx power was calculated and is presented in the following graphs for each day of the capacity tests.

The summary of mean Tx power for each day is presented below in Table 7.4-1.

**Table 7.4.1. Mean Tx Power**

| Date | Mean Tx Power |
|---|---|
| 11/18/1991 | 0.5 (dBm) = 1.1 (mWatts) |
| 11/20/1991 | 15.2 (dBm) = 33.1 (mWatts) |
| 11/21/1991 | 4.9 (dBm) = 3.1 (mWatts) |
| 11/21/1991 | 5.8 (dBm) = 3.8 (mWatts) |
| 11/23/1991 | 13.6 (dBm) = 22.9 (mWatts) |

A low mean Tx power of 0.5 dBm was achieved on November 18, 1991 because of the proximity of the mobiles to the cell site. The Fiesta Island route was fairly flat, free of tall buildings and other impediments, and in general, fostered low propagation.

The much higher Tx power of 15.2 dBm achieved on November 20th, 1991 was due to several factors. The geometry of the Old Town route contained a higher amount of multipath than the fiesta island route and fostered shadowing under certain conditions. Also, because many of the mobiles drove at the boundaries of the active cell sector into an area where handoff normally occurs, and the other cell sections were not active, the calls which under normal fully-loaded conditions would have been placed in soft-handoff mode, dropped-off and had to be re-initiated.

The mean Tx power achieved for November 21 and 22 were well within the expectations of the system performance for the test scenario of each day.

On the November 23, 1991 external interference tests were conducted and caused an increase in the Tx Power.

All the mobiles that participated in capacity tests (Alpha II mobiles) had a maximum output power of 25 dBm. Therefore a request to generate more than 25 dBm resulted in the maximum available output. This effect caused a spike at 25 dBm on the Tx power distribution charts.

### 7.4.1 Summary of Results of Rx Power, Tx Power Tx Gain

A summary of the means of Rx power, Tx power, and Tx gain adj. for each day and each mobile that was logged is given in Tables 7.4.1-1 through 7.4.1-5 and summarized in Table 7.4.1-6 .

Table 7.4.1-7 highlights the minimum value, maximum value of the calculated means of the Rx power, Tx power and Tx gain adj. for all the mobiles over all testing days.

**Table 7.4.1-2 Result Summary of Tx Power, Rx Power, and Tx Gain Adj.**

| Signal | Minimum Value | Maximum Value | Mean and Std Deviation |
|---|---|---|---|
| Rx Power | -84.40 [dBm] | -40.40 [dBm] | Mean = -63.13 [dBm]<br>Std. Dev. = 10.73 [dB] |
| Tx Power | -21.7[dBm] | 19.7 [dBm] | Mean = 4.50 [dBm]<br>Std. Dev. = 11.08 [dB] |
| Tx Gain Adj. | -8.80 [dB] | 23.20 [dB] | Mean = 6.14 [dB]<br>Std. Dev = 6.98 [dB] |

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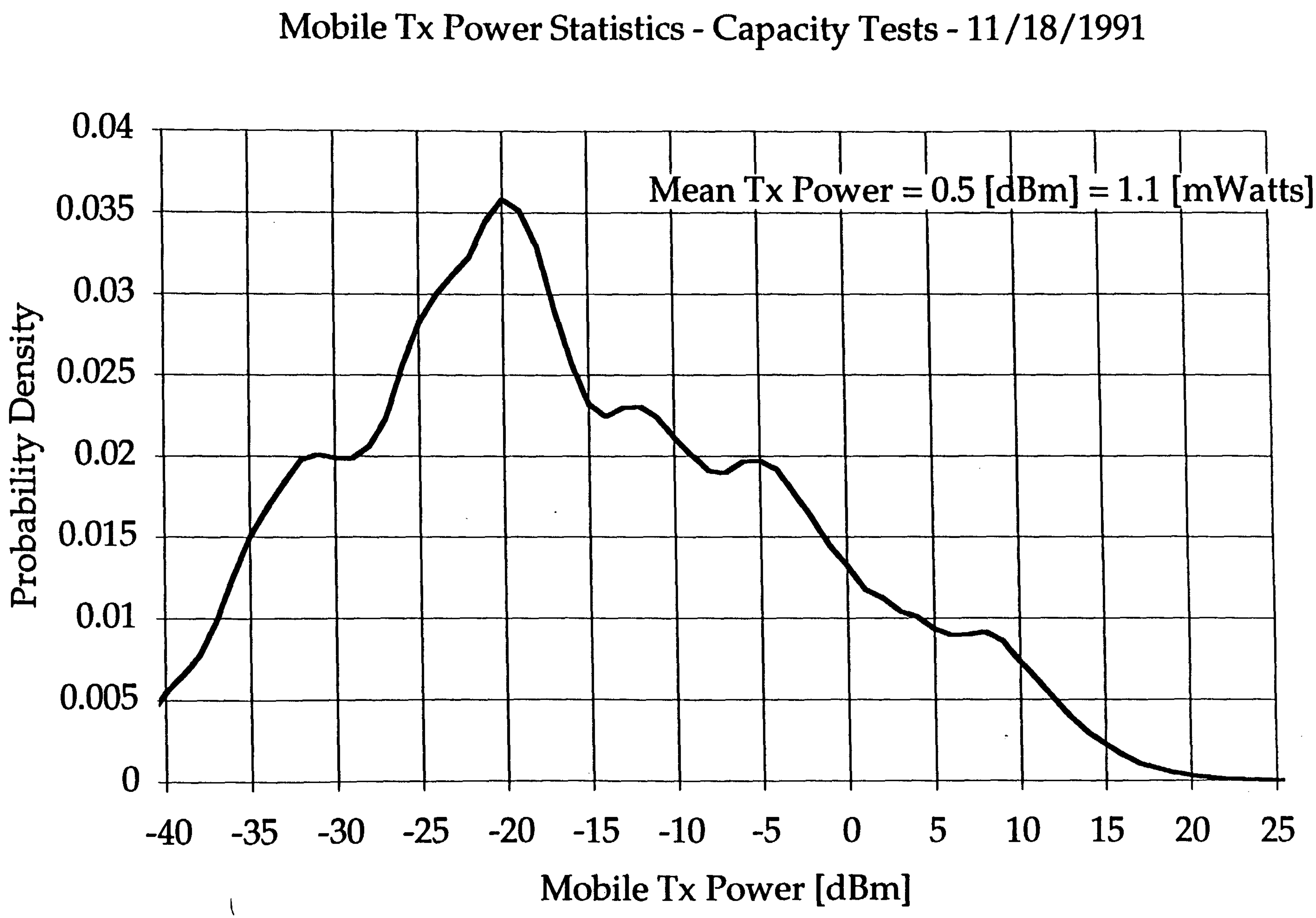
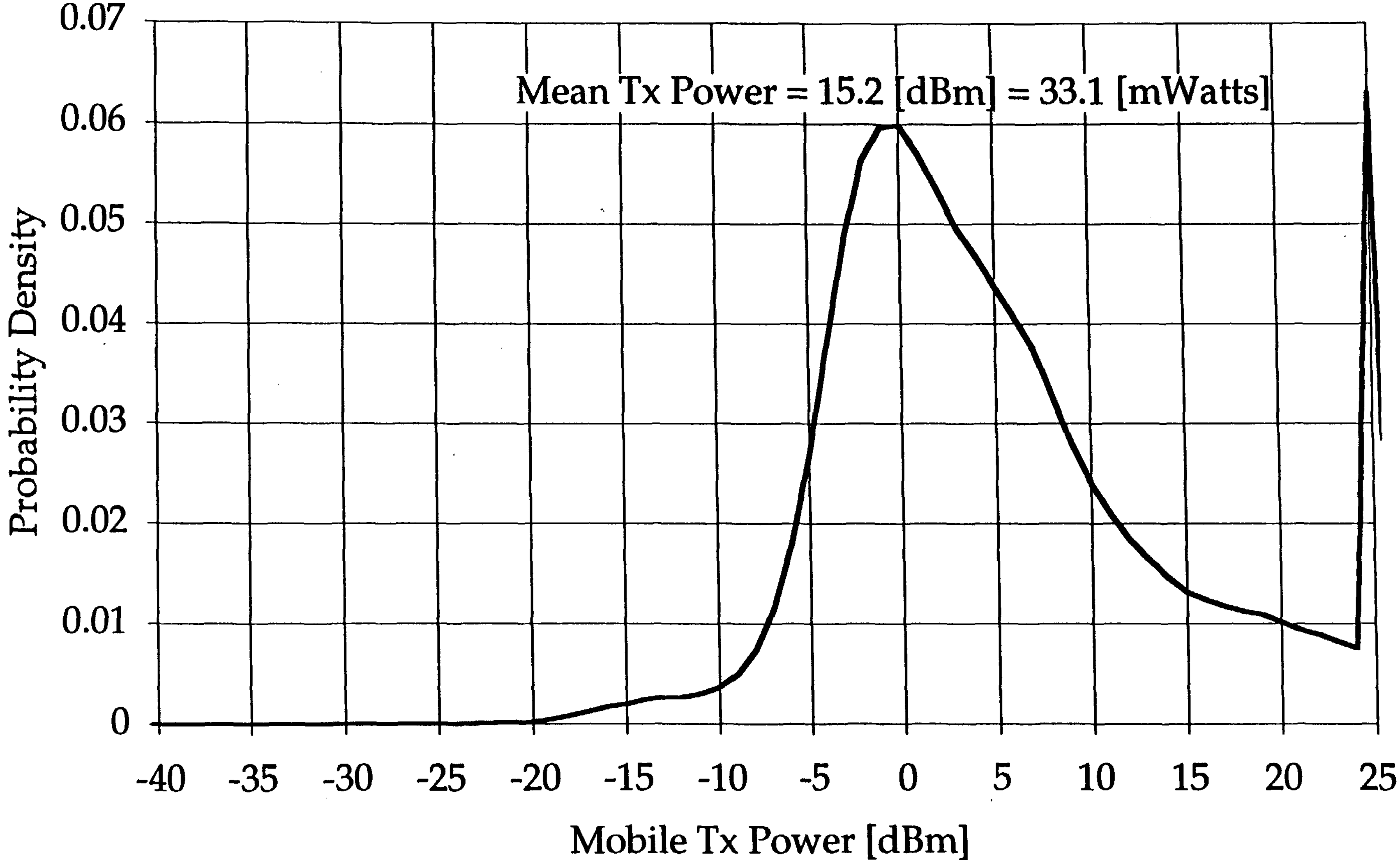
# Tx Power Charts
# for 11/18/1991 through 11/23/1991

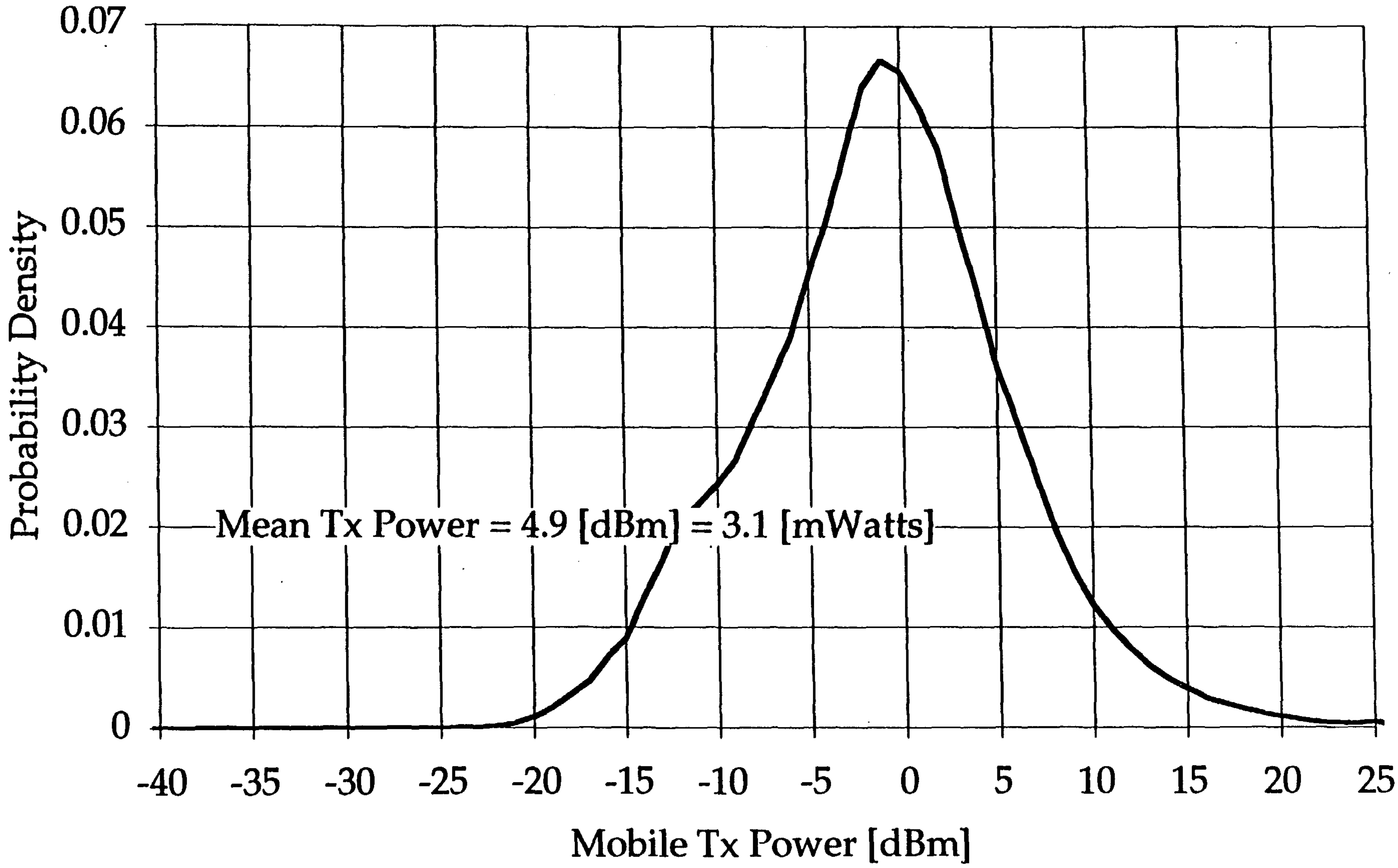


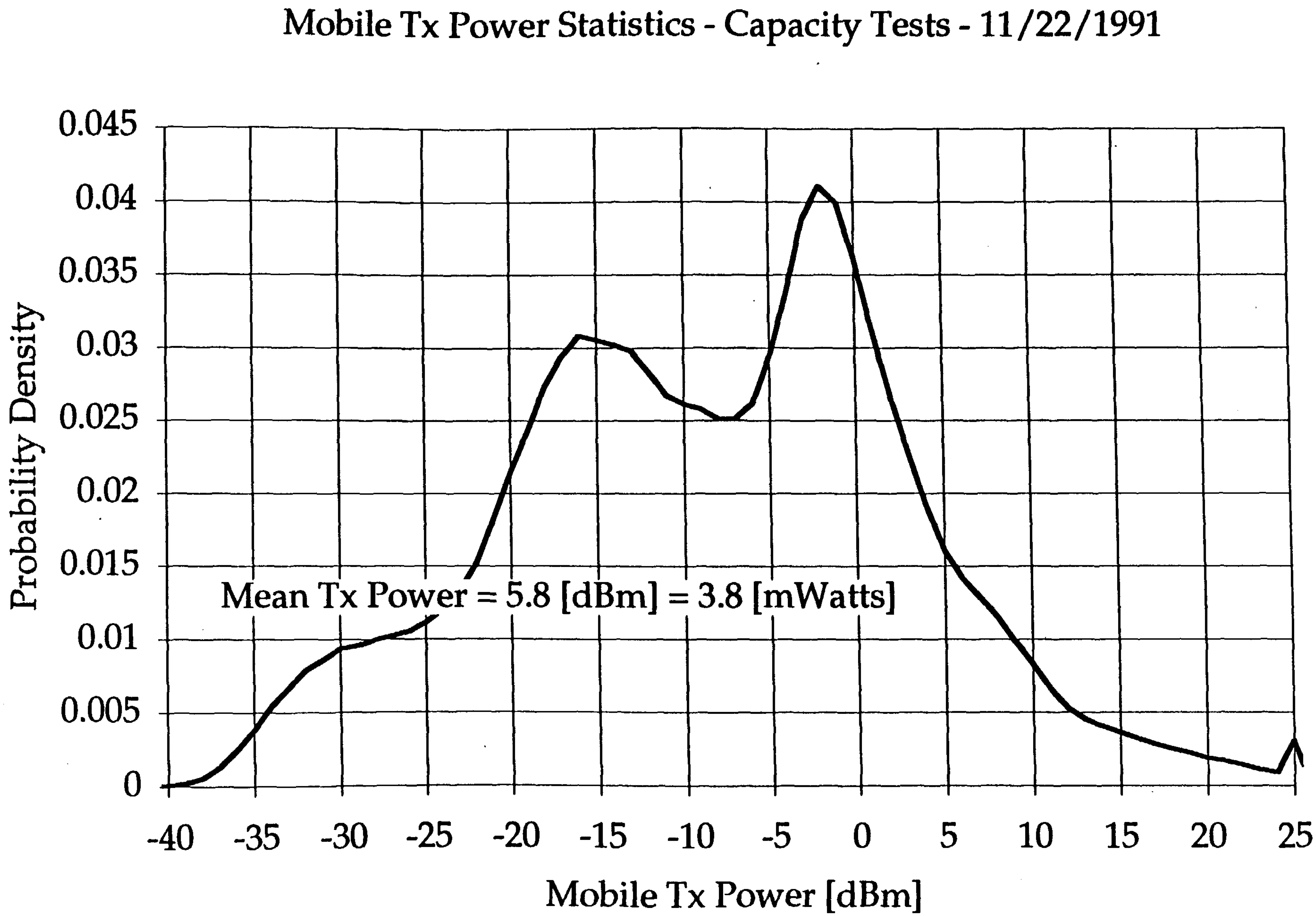
Mobile Tx Power Statistics - Capacity Tests - 11/18/1991
Mean Tx Power = 0.5 [dBm] = 1.1 [mWatts]
Probability Density
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
Mobile Tx Power [dBm]

Mobile Tx Power Statistics - Capacity Tests - 11/20/1991

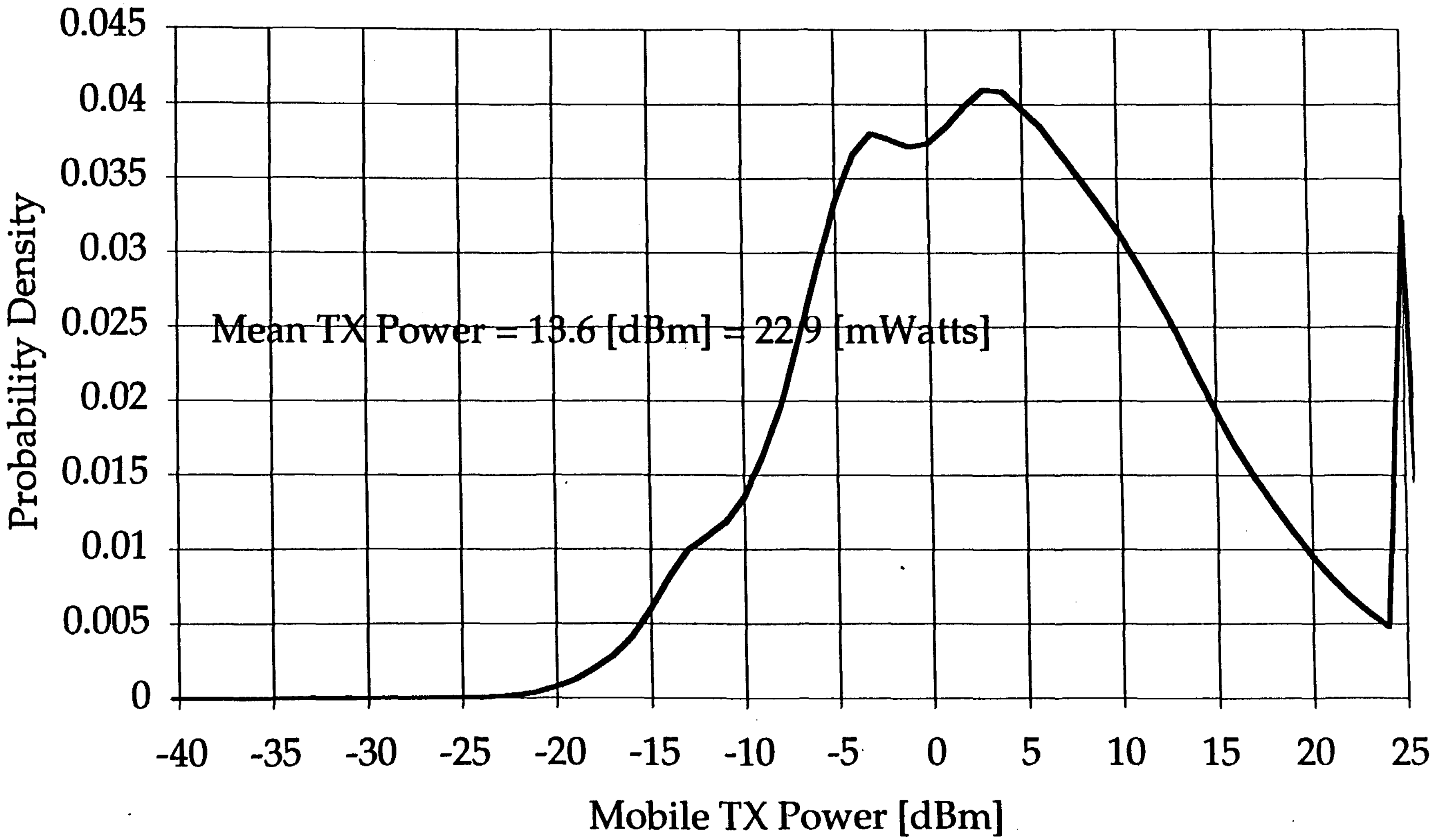


Mobile Tx Power Statistics - Capacity Tests - 11/21/1991




Mobile Tx Power Statistics - Capacity Tests - 11/22/1991
Probability Density
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Mean Tx Power = 5.8 [dBm] = 3.8 [mWatts]
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
Mobile Tx Power [dBm]

Mobile TX Power Statistics - Capacity Tests - 11/23/1991



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# Tx Power, Rx Power and Tx Gain Adjust Tables for 11/18/1991 through 11/23/1991